

2002 Annual Report of Winter Chinook Propagation Activities

A U.S. Fish & Wildlife Service Report

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INTRODUCTION

Due to severe declines in adult returns, the National Marine Fisheries Service listed Sacramento River winter Chinook salmon as threatened under the emergency listing procedures for the Endangered Species Act (16 U.S.C.R. 1531-1543) on August 4, 1989 (54 Federal Register 32085). Winter Chinook were formally added to the list of federally threatened species by final rule on November 5, 1990 (55 Federal Register 46515). Despite early efforts to restore the population, adult returns of winter Chinook continued to decline. In January 1994, the National Marine Fisheries Service reclassified winter Chinook salmon as endangered.

To supplement natural production and reduce the risk of extinction, the U.S. Fish and Wildlife Service (Service) developed an artificial propagation program for winter Chinook salmon in 1989. The program was located at Coleman National Fish Hatchery (NFH), on Battle Creek, a tributary of the Sacramento River. However, fish reared at Coleman NFH tended to return to Battle Creek rather than the Sacramento River as desired. To alleviate this problem, a new hatchery facility, Livingston Stone National Fish Hatchery (NFH), was established in 1998 along the Sacramento River at the base of Shasta Dam. To ensure that the hatchery program spawned only winter Chinook, the Service implemented a genetic-based screening process to identify winter Chinook salmon.

In addition to the hatchery supplementation program, an experimental captive broodstock program was cooperatively developed in 1991 with Bodega Marine Lab (BML) and partner agencies of the winter Chinook captive brood stock technical committee. The winter Chinook captive broodstock program is sustained by rearing a small number of hatchery-origin juveniles to maturity at Livingston Stone NFH or the BML. The primary objective of the winter Chinook captive broodstock program is to determine if a captive brood program could be used to prevent extinction of the run by ensuring a source of gametes for the supplementation program in the event that run sizes continue to decline and too few fish are available for hatchery broodstock (in 1991 the winter Chinook run estimate was less than 200 individuals). The year 2002 marks the second year of juvenile releases for a study to evaluate the efficacy of fish produced from the captive-brood program to produce returning adults (USFWS 2003).

METHODS

Broodstock

Collection

Before collection of winter Chinook broodstock began in 2002, the Service developed a broodstock collection plan that defined brood fish collection targets spread throughout the run. The broodstock collection guidelines for winter Chinook allow capture of up to 15% of the run size, up to a maximum of 120 fish. A run size of 800 or greater, would allow for 120 fish to be

retained as brood stock. In 2002, the pre-season run estimate was much greater than 800; therefore, up to 120 adult winter Chinook salmon could be collected. The timing of broodstock collection was scheduled to mimic the historic migration timing past the Red Bluff Diversion Dam as follows: 1.8% (2 fish) in December, 5.1% (6 fish) in January, 9.6% (12 fish) in February, 36.0% (43 fish) in March, 28.6% (34 fish) in April, 8.9% (11 fish) in May, 6.8% (8 fish) in June, and 3.4% (4 fish) in July. Deviation from the broodstock collection plan can occur due to limitations of the available traps to function during the entire run, under all flow conditions and other factors. Two traps were operated in 2002 to collect winter Chinook broodstock. The Keswick Dam fish trap (river mile 302) is operational only when discharge from Keswick dam is less than 32,000 cubic feet per second. As such, trap operation is affected by reservoir management. The Keswick trap was the primary trap used in 2002 and was operated by Service personnel. The Red Bluff Diversion Dam (RBDD) fish trap (river mile 243), was operated by the California Department of Fish and Game, and was a secondary source of broodstock. The RBDD trap can only be operated when the dam gates are lowered which typically occurs from May 15 – September 15.

Handling and Transportation

Once trapped in the Keswick Dam fish trap, the fish remained in water at all times. From the trap they swam into a 1,000 gallon bail-lift from which they were transferred directly into an aerated and insulated 1,200 or 1,600-gallon transport tank and driven a short distance to Livingston Stone NFH. At Livingston Stone NFH the fish were anaesthetized with CO₂ while still in the transport tank, after which they were handled and a preliminary run assignment was made (i.e., winter-run or non-winter-run) based on phenotypic characteristics (e.g., color, degree of ripeness, fish size, amount of fungus, and collection date). All fish received a floy tag below the dorsal fin, and a small piece of fin tissue was taken for genetic analysis. Fish classified as non-winter-run were transported back to the Sacramento River the same day they were removed from the trap, or were transported to Coleman NFH for use in the late-fall Chinook broodstock program. Fish classified as phenotypically winter-run were quarantined in a 20-foot circular tank pending genetic confirmation of their run type. Fish genetically confirmed as winter-run were transferred into a 20-foot circular adult holding tank until spawned. Those identified as non-winter-run were returned to the Sacramento River.

Salmon trapped at the Red Bluff Diversion Dam trap were anesthetized with carbon dioxide and sorted to run type based on phenotypic characteristics. Phenotypic winter Chinook were netted from the trap and placed in a flow-through retention tube until transport to Livingston Stone NFH. Phenotypic non-winter Chinook were released on-site.

Run Identification

A genetic-based run assignment was used to classify fish as either winter-run or non-winter-run Chinook (University of California, Davis - Bodega Marine Laboratory 2001). Analyses were conducted at Bodega Marine Lab. Tissue samples were analyzed at a suite of microsatellite markers selected for their diagnostic power in distinguishing winter Chinook from other Chinook

salmon populations (University of California – Davis Bodega Marine Laboratory 2001). Following the methods described by Banks et al. (1999) and Greig and Banks (1999), extracted DNA from samples was amplified by polymerase chain reaction, analyzed, and overall genotypes converted to GENEPOP format. Duplicate samples were run to confirm genotypes. A log-of-the-odds (LOD) score was generated using the computer software WHICHRUN (Banks and Eichert 2000) and used to assign individual Chinook as either winter-run or non-winter-run. A LOD score of two or greater, based on seven loci, was used to determine which fish would be retained as broodstock. Run-assignments for individual fish were transmitted back to Livingston Stone NFH usually within one to seven days from shipment of the tissue sample to Bodega Marine Lab.

Health

Various therapeutic and prophylactic treatments were used on winter Chinook salmon broodstock to increase survival of adults and reduce risks of disease transmission to offspring (Table 1). Additionally, effects of stress on broodstock were reduced with salt, Poly Aqua, and anesthetics. Hatchery personnel and staff from the California-Nevada Fish Health Center closely monitored fish health. Broodstock were treated with malachite green to prevent fungal infections and erythromycin injections (target dosage of 20 mg/kg) were used to prevent transmission of *Renibacterium salmoninarum* to the progeny. No chemical treatments were administered to fish while held in quarantine and fish returned to the river were not subjected to chemical treatments. California-Nevada Fish Health Center personnel tested for the presence of pathogens in the broodstock.

Table 1. Drugs and treatments that may be applied to maintain the health of winter Chinook salmon held at Livingston Stone National Fish Hatchery.

Drug/Treatment	Dosage	Administered by	Use
Erythromycin	20 mg/kg	dorsal sinus injection	antibacterial
Iodophor	75 ppm	bath	antibacterial
Malachite green	1 ppm	bath	antifungal
Formalin	167 ppm	flow through	antifungal
MS-222		bath	anesthetic
<i>Vibrio</i> spp. vaccine		bath	vaccination against salt-water <i>Vibrio</i> spp.
Poly Aqua	1 qt/1,200 gallons	bath/flow through	stress reducer
Salt		bath/flow through	stress reducer
Chloramine-T	15 ppm	bath	antibacterial

Spawning

Winter Chinook held as broodstock were examined twice weekly to assess their state of sexual maturity. Fish were crowded into a pie-shaped containment area using a hinged crowder consisting of two solid vinyl-covered screens. Tricaine methanesulfonate (MS-222) was added to anaesthetize the fish so they could be examined for maturity and overall fish health.

Luteinizing Hormone-Releasing Hormone analogue (LH-RH_a) implants were administered to accelerate final gamete maturation in fish that had already undergone gametogenesis and to synchronize maturation of broodstock (Tables 2 and 3). The LH-RH_a implants release 30% of their content in the first three days after injection and the remaining hormone over a 20-day period to sustain an effective concentration within the fish. The implant dosage was 150 or 250 µg (supplied by Syndel International Inc.). Implants were injected into the dorsal muscle lateral and anterior to the dorsal fin with the use of a Ralgro pellet injector. Thirty-three females and three males received LH-RH_a injections.

When a female salmon was identified as being sexually mature, it was euthanized, removed from the tank, and rinsed in fresh water to remove any remaining MS-222. Each female was assigned a number and each male was assigned a letter. The caudal artery of the female was severed so that blood would not mix into the eggs. Eggs were removed by making an incision from the vent to the pectoral fin and separated into two approximately equal groups. Each group was fertilized with semen from a different male, forming two half-sibling family groups. For example, when female 1 was spawned with males A and B, “family groups” 1A and 1B were created. After mixing semen and eggs, tris-glycine buffer was added to extend sperm life and motility. Spawned males were either returned to the holding tank for additional spawning or euthanized. Males were spawned a maximum of four times. When possible, each fish captured from the Sacramento River was spawned with at least two others. Captive-origin females were only spawned with natural-origin males.

Table 2. Spawning and drug treatment history of individual female Chinook salmon held at Livingston Stone National Fish Hatchery, 2002.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-240	2/20/02	742	12.1	5/28/02	5/28/02	96	0.6	2	250	1	20
OR-244	4/3/02	789	14.54	5/20/02	5/20/02	46	0.6	2	250	1	10
OR-245	4/3/02	741	12.36	6/28/02	6/28/02	85	0.6	3	n/a	none	20
OR-246	4/10/02	758	12.56	6/3/02	6/3/02	53	0.6	2	250	2	12
OR-289	4/17/02	768	14.68	PSM ^a	5/15/02	27	0.6	1	250	1	6
OR-263	4/17/02	698	9.9	4/24/02	4/24/02	6	n/a ^b	none	n/a	none	none
OR-249	4/17/02	780	13.2	4/24/02	4/24/02	6	n/a	none	n/a	none	none
OR-293	4/17/02	745	11.48	4/30/02	4/30/02	12	0.5	1	n/a	none	1
OR-294	4/17/02	749	11.4	4/30/02	4/30/02	12	0.5	1	n/a	none	1
OR-248	4/17/02	766	11.86	4/30/02	4/30/02	12	0.5	1	n/a	none	1
OR-250	4/17/02	790	13.8	5/13/02	5/13/02	25	0.6	1	250	1	5
OR-266	4/17/02	763	12.44	5/13/02	5/13/02	25	0.6	1	250	1	5
OR-259	4/17/02	788	14.3	5/13/02	5/13/02	25	0.7	1	n/a	none	5
OR-290	4/17/02	770	13.4	5/15/02	5/15/02	27	0.6	1	250	1	6
OR-253	4/17/02	765	12.18	5/20/02	5/20/02	32	0.6	1	250	1	7
OR-255	4/17/02	735	10.68	5/20/02	5/20/02	32	0.5	1	250	1	7
OR-279	4/17/02	781	13.04	5/23/02	5/23/02	35	0.6	1	250	1	8
OR-278	4/17/02	798	13.9	5/23/02	5/23/02	35	0.6	1	250	1	8
OR-268	4/17/02	749	12.66	5/28/02	5/28/02	40	0.6	1	250	1	9
OR-261	4/17/02	748	11.44	6/3/02	6/3/02	46	0.5	2	250	1	11
OR-252	4/17/02	759	12.22	6/3/02	6/3/02	46	0.6	2	250	1	11
OR-256	4/17/02	698	8.9	6/5/02	6/5/02	48	0.4	1	150	1	12
OR-288	4/17/02	758	11.02	6/10/02	6/10/02	53	0.5	3	250	1	13
OR-276	4/17/02	744	11.9	6/10/02	6/10/02	53	0.5	2	250	1	13

Table 2—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-270	4/17/02	681	8.62	6/10/02	6/10/02	53	0.4	4	150	1	13
OR-260	4/17/02	818	16.8	6/13/02	6/13/02	56	0.7	2	250	1	14
OR-274	4/17/02	698	9.66	6/20/02	6/20/02	63	0.5	2	n/a	none	16
OR-291	4/17/02	742	10.42	6/24/02	6/24/02	67	0.5	2	250	1	17
OR-292	4/17/02	665	7.52	6/28/02	6/28/02	71	0.4	2	n/a	none	18
OR-267	4/17/02	748	12.18	7/1/02	7/1/02	74	0.6	2	n/a	none	18
OR-275	4/17/02	781	12.96	7/1/02	7/1/02	74	0.6	2	250	1	18
OR-277	4/17/02	746	11.76	7/8/02	7/8/02	81	0.5	3	250	1	20
OR-254	4/17/02	729	11.22	7/8/02	7/8/02	81	0.5	3	250	1	20
W-205	4/24/02	745	11.68	5/15/02	5/15/02	20	0.5	1	250	1	5
W-202	4/24/02	731	11.54	5/20/02	5/20/02	25	0.5	1	250	2	6
W-207	4/24/02	759	11.78	6/5/02	6/5/02	41	0.5	1	250	1	12
W-204	4/24/02	775	12.86	6/10/02	6/10/02	46	0.6	2	250	1	12
W-206	4/24/02	703	9.84	6/13/02	6/13/02	49	0.5	2	150	1	14
OR-300	4/24/02	712	9.94	6/13/02	6/13/02	49	0.5	2	n/a	none	14
W-203	4/24/02	758	13.54	6/17/02	6/17/02	53	0.6	2	250	1	15
OR-296	4/24/02	751	13.3	6/28/02	6/28/02	64	0.5	3	n/a	none	18
OR-297	4/24/02	755	10.88	7/4/02	7/4/02	70	0.5	3	250	1	19
R-04044	4/24/02	723	10.54	7/4/02	7/4/02	70	0.5	3	250	1	19
W-224	5/1/02	815	15.4	5/9/02	5/9/02	7	n/a	none	n/a	none	1
W-223	5/1/02	775	13.1	6/13/02	6/13/02	42	0.6	2	250	1	11
W-215	5/1/02	769	13.26	6/17/02	6/17/02	46	0.6	2	n/a	none	12
W-227	5/29/02	769	11.8	6/20/02	6/20/02	21	0.5	1	n/a	none	5
W-240	6/19/02	765	12.4	PSM ^a	7/7/02	17	0.5	1	250	1	3

Table 2—cont

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
W-235	6/19/02	747	12.4	6/20/02	6/20/02	1	n/a	none	n/a	none	none
W-244	6/19/02	732	10.6	6/24/02	6/24/02	4	n/a	none	n/a	none	none

^a Pre-spawn mortality; ^b not applicable

Table 3. Spawning and drug treatment history of individual male Chinook salmon held at Livingston Stone National Fish Hatchery, 2002.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-239	2/20/02	842	14.4	PSM ^a	3/18/02	25	n/a ^b	none	n/a	none	4
OR-287	4/17/02	758	12.8	PSM ^a	5/28/02	40	0.6	1	250	1	8
OR-251	4/17/02	714	10.4	4/24/02	5/9/02	21	n/a	none	n/a	none	4
OR-251				4/24/02							
OR-251				4/30/02							
OR-251				4/30/02							
OR-284	4/17/02	809	10.9	4/24/02	5/9/02	21	n/a	none	n/a	none	4
OR-284				4/30/02							
OR-284				4/30/02							
OR-282	4/17/02	753	11.9	4/24/02	5/15/02	27	n/a	none	n/a	none	6
OR-282				4/30/03							
OR-282				5/13/02							
OR-283	4/17/02	750	11.8	4/30/02	5/20/02	32	n/a	none	n/a	none	7
OR-283				5/9/02							
OR-283				5/13/02							
OR-285	4/17/02	933	21.9	5/9/02	5/15/02	27	n/a	none	n/a	none	6
OR-285				5/13/02							
OR-285				5/13/02							
OR-273	4/17/02	760	12.6	5/13/02	5/20/02	32	n/a	none	n/a	none	7
OR-273				5/15/02							
OR-273				5/20/02							
OR-271	4/17/02	970	26.2	5/13/02	5/20/02	32	n/a	none	n/a	none	7
OR-271				5/15/02							

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-271	4/17/02	970	26.2	5/20/02	5/20/02	32	n/a	None	n/a	None	7
OR-272	4/17/02	880	18.0	6/6/02	7/4/02	77	n/a	none	n/a	none	20
OR-272				6/13/02							
OR-272				6/13/02							
OR-280	4/17/02	1000	26.5	5/15/02	5/28/02	40	n/a	none	n/a	none	9
OR-280				5/20/02							
OR-280				5/23/02							
OR-281	4/17/02	818	15.4	5/20/02	5/20/02	32	n/a	none	n/a	none	7
OR-281				5/20/02							
W-247	4/17/02	860	19.0	6/10/02	7/12/02	85	n/a	none	n/a	none	21
W-247				6/13/02							
W-247				6/20/02							
OR-258	4/17/02	903	20.9	6/13/02	6/21/02	64	n/a	none	n/a	none	16
OR-258				6/17/02							
OR-258				6/17/02							
OR-286	4/17/02	758	12.6	6/13/02	7/23/02	96	n/a	none	n/a	none	22
OR-286				6/20/02							
OR-269	4/17/02	585	5.7	6/20/02	7/23/02	96	n/a	none	n/a	none	22
OR-269				7/4/02							
OR-264	4/17/02	765	11.9	6/20/02	7/15/02	88	n/a	none	n/a	none	21
OR-264				6/20/02							
No tag	4/17/02	452	2.7	7/4/02	7/8/02	81	n/a	none	n/a	none	20
No tag				7/8/02							

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
W-209	4/24/02	528	3.5	PSM ^a	5/31/02	36	n/a	none	n/a	none	6
OR-295	4/24/02	890	21.2	5/23/02	6/3/02	39	n/a	none	n/a	none	11
OR-295				5/28/02							
OR-295				6/3/02							
OR-298	4/24/02	778	12.6	5/28/02	5/28/02	33	n/a	none	n/a	none	9
OR-298				5/28/02							
OR-299	4/24/02	953	19.4	6/10/02	6/11/02	47	n/a	none	n/a	none	14
OR-299				6/10/02							
W-201	4/24/02	495	3.4	6/3/02	6/24/02	60	n/a	none	150	1	17
W-201				6/6/02							
W-201				6/10/02							
W-217	5/1/02	530	4.4	PSM ^a	6/10/02	39	n/a	none	n/a	none	9
W-222	5/1/02	775	11.8	PSM ^a	6/19/02	48	n/a	none	n/a	none	12
W-210	5/1/02	808	19.0	5/23/02	6/3/02	32	n/a	none	n/a	none	7
W-210				5/28/02							
W-210				6/3/02							
W-212	5/1/02	801	14.2	5/20/02	5/20/02	18	n/a	none	n/a	none	4
W-212				5/20/02							
W-216	5/1/02	796	13.9	5/15/02	5/23/02	21	n/a	none	n/a	none	4
W-216				5/20/02							
W-216				5/23/02							
W-219	5/1/02	505	3.6	6/3/03	6/13/02	42	n/a	none	n/a	none	10
W-219				6/6/02							
W-219				6/10/02							

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
W-221	5/1/02	495	3.7	6/10/02	7/24/02	83	n/a	none	150	1	18
W-221				6/13/02							
W-246	5/1/02	790	13.3	6/20/02	7/12/02	71	n/a	none	n/a	none	17
W-246				6/24/02							
W-211	5/1/02	858	16.2	7/1/02	8/1/02	91	n/a	none	n/a	none	21
W-211				7/8/02							
W-214	5/1/02	480	3.2	7/1/02	7/26/02	85	n/a	none	n/a	none	17
W-220	5/1/02	480	2.9	6/28/02	7/23/02	82	n/a	none	n/a	none	18
W-220				7/1/02							
W-225	5/29/02	708	10.1	6/10/02	6/24/02	25	n/a	none	n/a	none	6
W-225				6/10/02							
W-225				6/13/02							
W-226	5/29/02	874	19.3	6/3/02	6/24/02	25	n/a	none	n/a	none	6
W-226				6/3/02							
W-226				6/6/02							
W-226				6/13/02							
W-231	6/12/02	890	17.8	6/17/02	6/18/02	5	n/a	none	n/a	none	1
W-229	6/12/02	505	3.5	6/28/02	7/8/02	25	n/a	none	n/a	none	5
W-230	6/12/02	588	4.3	6/28/02	7/4/02	21	n/a	none	n/a	none	4
W-239	6/19/02	600	5.5	PSM ^a	7/1/02	11	n/a	none	n/a	none	1
W-236	6/19/02	653	8.1	6/24/02	7/8/02	18	n/a	none	n/a	none	3
W-236				6/24/02							
W-242	6/19/02	798	13.2	6/24/02	7/11/02	21	n/a	none	n/a	none	4
W-242				6/28/02							
W-241	6/19/02	760	12.8	6/28/02	7/15/02	25	n/a	none	n/a	none	4

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
W-241				7/8/02							
W-245	6/19/02	588	5.2	6/28/02	7/11/02	21	n/a	none	n/a	none	4
W-245				7/1/02							
W-243	6/19/02	695	8.6	7/4/02	7/15/02	25	n/a	none	n/a	none	4
W-243				7/8/02							
W-238	6/19/02	608	6.0	7/4/02	7/15/02	25	n/a	none	n/a	none	4

^a Pre-spawn mortality; ^b not applicable

Progeny

Eggs and Juvenile Rearing

After fertilization, winter Chinook eggs were placed in Heath incubator trays and disinfected with 75 parts per million (ppm) iodophor bath for 15 minutes. To help prevent excessive fungus, incubating eggs were treated twice a week with 1,400 ppm formalin for 15 minutes as a flow-through treatment. Initial water flow in the incubator trays was four gallons per minute (gpm) and later increased to six gpm at eye-up. After eye-up, eggs were shocked and non-viable eggs were removed. Formalin treatments were discontinued once eggs had hatched. Sac fry were left in the incubator trays until button-up, at which time they were transferred to 30-inch diameter (10.2 cubic foot) circular tanks and started on commercial feed.

Juveniles were initially fed Bio-Oregon's starter #1. *Artemia nauplii* (Cyclop-eeze™ from Argent Chemical Laboratories) were added to increase interest in the feed. The fish were subsequently fed Bio-Oregon's starter #2 and starter #3 fish feed. Once they attained a size of approximately 500 to-the-pound, they were fed Bio-Oregon's Biodiet grower, size 1.3 mm pellets. At a size of about 250 to-the-pound they were fed Biodiet grower, size 1.5 mm pellets, until released. Feeding rates were determined using Bio-Oregon's feeding guidelines which indicate the appropriate feed ration based on average monthly water temperature. Due to tank space limitations at Livingston Stone NFH, family groups were combined as fish size increased.

Health

To maintain sanitary rearing environments, rearing units were typically cleaned two to five times per week. Juvenile winter Chinook were tested for the presence of pathogens by California-Nevada Fish Health Center personnel. Juveniles selected for incorporation into the captive broodstock program were vaccinated against *Vibrio*. Vaccinations were performed by mixing the formalin-inactivated bacteria solution with water (one to ten ratio), then dipping the fish in this solution for 20 seconds.

Marking and Tagging

All winter Chinook juveniles were coded-wire tagged between December 16, 2002 and January 8, 2003. Each of the 28 natural-origin by natural-origin family group combinations received a unique tag code as did four hatchery-origin by natural-origin family group combinations and three captive-origin by natural-origin family group combinations (Table 4).

Juveniles retained for the captive broodstock program were tagged with passive integrated transponder (PIT) tags. At the time of tagging, a small piece of fin was removed for genetic-based determination of sex. Captive broodstock males and females were reared separately so that feeding schedules could be gender-specific. This was done to limit growth and fat deposition in males, reducing the likelihood of precocious maturation.

Table 4. Brood year 2002 winter Chinook salmon released by coded-wire tag (CWT) code, family group, and parental origin.

Tag Code	Family Group	Parental Origin ^a	Number Tagged	Tagging Mortalities	Proportion Tags Retained	Tagged Fish Released	Number Released	Average Fork Length (mm)	Min. Fork Length (mm)	Max. Fork Length (mm)
051276	41DD, 42II	N x N	3,893	21	0.97	3,756	3,872	78	65	94
051277	38DD, 39CC	N x N	4,671	15	0.930	4,330	4,656	71	34	86
051278	40EE, 45MM	N x N	4,584	18	0.970	4,429	4,566	73	55	86
051279	46Z, 47MM	N x N	4,039	15	0.935	3,762	4,024	73	64	89
051280	46NN, 48HH	N x N	4,415	15	0.960	4,224	4,400	72	52	83
051281	35Y, 36AA	N x N	4,470	18	0.975	4,341	4,452	80	58	91
051282	1B, 2C, 3B	N x N	6,199	17	0.915	5,657	6,182	82	55	96
051283	4C, 5D, 6E	N x N	6,275	54	0.865	5,381	6,221	79	53	95
051284	7C, 7E, 8E, 8F, 9D, 9G, 10G, 10H, 11F, 11I	N x N	5,990	45	0.910	5,410	5,945	80	48	96
051285	13F, 14H	N x N	4,593	15	0.905	4,143	4,578	86	67	102
051286	15I, 18L	N x N	5,153	20	0.975	5,005	5,133	83	34	99
051287	21O, 24R	N x N	4,035	29	0.850	3,405	4,006	79	45	106
051288	25P, 27U, 28T	N x N	5,564	17	0.900	4,992	5,547	78	56	96
051289	26S, 28V, 30O	N x N	6,098	24	0.960	5,831	6,074	78	55	93
051292	43JJ, 43KK	N x N	4,623	16	0.950	4,377	4,607	74	57	87
051293	38CC, 39BB	N x N	4,700	17	0.950	4,449	4,683	74	54	86
051295	22O, 22Q	N x N	2,664	12	0.865	2,294	2,652	91	67	106
051296	1A, 2A, 3A, 4A, 5B	N x N	11,011	37	0.950	10,425	10,974	80	50	107
051299	26Q, 29W	N x N	4,425	18	0.985	4,341	4,407	83	67	94
051364	23O, 23P, 24Q, 25S	N x N	5,309	29	0.905	4,778	5,280	79	53	93
051365	21P, 30U	N x N	4,622	19	0.920	4,235	4,603	79	52	98
051366	29V, 32R	N x N	4,567	28	0.970	4,403	4,539	79	66	94

Table 4-- cont.

Tag Code	Family Group	Parental Origin ^a	Number Tagged	Tagging Mortalities	Proportion Tags Retained	Tagged Fish Released	Number Released	Average Fork Length (mm)	Min. Fork Length (mm)	Max. Fork Length (mm)
051367	27T, 31R	N x N	4,830	15	0.970	4,671	4,815	82	65	99
051368	32Y, 33W, 34W	N x N	4,541	22	0.985	4,451	4,519	78	53	96
051369	35Z, 36BB	N x N	4,736	15	0.965	4,556	4,721	75	59	90
051370	31T, 33X	N x N	4,731	16	0.995	4,691	4,715	78	64	94
051372	42HH, 48JJ	N x N	5,093	18	0.980	4,974	5,075	73	54	90
051373	20L, 20M	N x N	4,481	52	0.955	4,230	4,429	77	46	93
			Subtotal	637	.	131,540	139,675			
051290	13J, 14K, 15K, 18N, 19N	H x N	8,940	5	0.910	8,131	8,935	82	50	108
051291	41GG, 44II, 45LL	H x N	5,830	4	0.975	5,680	5,826	74	59	86
051294	40FF, 44EE	H x N	4,702	1	0.955	4,489	4,701	75	56	85
051371	37V, 37AA, 47LL	H x N	5,687	18	0.950	5,386	5,669	72	46	93
			Subtotal	28	.	23,686	25,131			
051297	BML 1 Through 20	C x N	18,599	28	0.935	17,364	18,571	72	33	100
051298	BML 21 Through 53	C x N	27,765	333	0.990	27,158	27,432	64	44	85
053737	BML 54 Through 95	C x N	22,944	140	0.990	22,576	22,804	65	44	87
			Subtotal	501	.	67,098	68,807			

^a "N" means natural-origin, "H" means hatchery-origin, "C" means captive-origin. All captive-origin fish were female.

Assessment of Potential Genetic Impacts

Prior to and following the release of juvenile winter Chinook into the Sacramento River, the Service estimated the “effective population size” of the winter Chinook salmon population, both with and without the influence of hatchery-origin fish. The effective population size estimate (N_e) measures the rate of genetic drift within a population and provides an assessment of risk of inbreeding resulting from the release of the juveniles from the hatchery propagation program. The N_e is directly related to the rate of loss of genetic diversity and the rate of increase in inbreeding within a population (Riemann and Allendorf 2001), and is an important concept in managing conservation programs for threatened or endangered salmonid populations, including Sacramento River winter Chinook. In most cases N_e is expected to be smaller than the actual number of adults in a spawning population.

The estimation of N_e was based on the estimated total run size of winter Chinook salmon to the Sacramento River in 2002. Two estimates of N_e were calculated: one assuming genetic contribution by 10% of the run size estimate (Bartley et al., 1992) and one assuming genetic contribution by 33% of the run size estimate (Robin Waples, NMFS, Northwest Fisheries Center, Seattle, WA, personal communication). The Service’s estimate of effective population size was sent to NOAA Fisheries and the California Department of Fish and Game for review and approval prior to releasing juvenile winter Chinook.

RESULTS

Broodstock

Collection and Disposition

The first winter-run Chinook was captured on February 20 and the last was captured on July 8 (Table 5, Figure 1). A large proportion of winter-run were collected on April 17 and May 1; a sharp increase in the proportion of nonwinter-run collected occurred later, in mid-June (Table 5, Figure 1). A total of 254 Chinook salmon were captured; 251 from the Keswick trap and three from the RBDD trap (Table 6). Seventy-eight percent ($n = 197$) of the fish captured were genetically identified as winter-run. Females comprised 53% ($n = 104$) of the winter Chinook salmon captured, males comprised 46% ($n = 90$), and gender could not be determined at the time of capture for 2% ($n = 3$) of the fish later identified as winter-run. Hatchery-origin fish comprised 30% ($n = 75$) of all the Chinook captured and 36% ($n = 71$) of the winter Chinook captured.

Ninety-eight winter-run Chinook and 50 non-winter-run Chinook, were collected and released without being quarantined as were two Chinook of undetermined run (Table 6). All non-quarantined fish were tissue sampled. Eight Chinook were held in quarantine and later released back into the Sacramento River; three of these fish were winter-run and five were non-winter-run

(Table 6). Quarantined fish were held for no more than seven days. Ninety-six winter Chinook salmon were retained for broodstock. Among these, 88 were spawned and eight died before they could be spawned.

Table 5. Chinook salmon captured and tissue sampled for genetic run assignment and final disposition. Fish with the adipose fin “present” were natural-origin, fish with the adipose fin “absent” were hatchery-origin.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
2/20/02	601	R-11779	Present	Male	983	Non-Winter	Released
2/20/02	602	R-11780	Present	Male	1005	Non-Winter	Released
2/20/02	603	R-11781	Present	Male	953	Non-Winter	Released
2/20/02	604	OR-238	Absent	Male	843	Winter	Released
2/20/02	605	R-11782	Present	Male	965	Non-Winter	Released
2/20/02	606	R-11783	Present	Male	952	Non-Winter	Released
2/20/02	607	OR-239	Present	Male	842	Winter	Mortality
2/20/02	608	R-11784	Present	Male	992	Non-Winter	Released
2/20/02	609	R-11785	Present	Male	864	Non-Winter	Released
2/20/02	610	OR-240	Present	Female	743	Winter	Spawned
2/27/02	611	R-11786	Present	Male	1030	Non-Winter	Released
3/6/02	612	R-11787	Absent	Male	981	Non-Winter	Released
3/13/02	613	R-11788	Present	Female	993	Non-Winter	Released
3/13/02	614	R-11789	Present	Female	881	Non-Winter	Released
3/13/02	615	R-11790	Present	Female	762	Winter	Released
3/13/02	616	OR-241	Absent	Female	756	Winter	Released
3/20/02	617	R-11791	Present	Male	950	Winter	Released
3/20/02	618	R-11792	Present	Male	816	Winter	Released
3/26/02	619	R-11793	Present	Female	830	Non-Winter	Released
3/26/02	620	OR-242	Present	Male	635	Non-Winter	Released
4/3/02	621	R-11794	Present	Male	927	Non-Winter	Released
4/3/02	622	R-11795	Present	Female	954	Non-Winter	Released
4/3/02	623	OR-243	Present	Male	680	Non-Winter	Released
4/3/02	624	OR-244	Present	Female	780	Winter	Spawned
4/3/02	625	OR-245	Present	Female	736	Winter	Spawned
4/10/02	626	OR-246	Present	Female	745	Winter	Spawned
4/10/02	627	OR-247	Present	Unknown	723	Non-Winter	Released
4/10/02	628	R-11796	Absent	Female	708	Winter	Released
4/10/02	629	R-11797	Absent	Female	760	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/10/02	630	R-11798	Absent	Female	776	Winter	Released
4/10/02	631	R-11799	Absent	Male	760	Winter	Released
4/17/02	632	R-11900	Present	Male	757	Winter	Released
4/17/02	633	R-11901	Absent	Female	733	Winter	Released
4/17/02	634	R-11902	Absent	Male	1000	Winter	Released
4/17/02	635	R-11903	Absent	Male	817	Winter	Released
4/17/02	636	R-11905	Absent	Female	803	Winter	Released
4/17/02	637	R-11906	Present	Male	957	Non-Winter	Released
4/17/02	638	R-11907	Absent	Male	800	Winter	Released
4/17/02	639	R-11908	Absent	Female	810	Winter	Released
4/17/02	640	R-11909	Absent	Female	783	Winter	Released
4/17/02	641	R-11910	Absent	Female	770	Winter	Released
4/17/02	642	R-11911	Absent	Female	805	Winter	Released
4/17/02	643	R-11912	Absent	Female	765	Winter	Released
4/17/02	644	OR-248	Present	Female	746	Winter	Spawned
4/17/02	645	OR-249	Present	Female	770	Winter	Spawned
4/17/02	646	OR-250	Present	Female	779	Winter	Spawned
4/17/02	647	OR-251	Present	Male	708	Winter	Spawned
4/17/02	648	OR-252	Present	Female	742	Winter	Spawned
4/17/02	649	OR-253	Present	Female	756	Winter	Spawned
4/17/02	650	OR-254	Present	Female	726	Winter	Spawned
4/17/02	651	OR-255	Present	Female	731	Winter	Spawned
4/17/02	652	OR-256	Present	Female	681	Winter	Spawned
4/17/02	653	W-247	Present	Male	845	Winter	Spawned
4/17/02	654	OR-258	Present	Male	891	Winter	Spawned
4/17/02	655	OR-259	Present	Female	781	Winter	Spawned
4/17/02	656	OR-260	Present	Female	808	Winter	Spawned
4/17/02	657	OR-261	Present	Female	739	Winter	Spawned
4/17/02	658	OR-262	Present	Female	665	Non-Winter	Released
4/17/02	659	OR-263	Present	Female	691	Winter	Spawned
4/17/02	660	OR-264	Present	Male	756	Winter	Spawned
4/17/02	661	OR-266	Present	Female	758	Winter	Spawned
4/17/02	662	OR-267	Present	Female	750	Winter	Spawned
4/17/02	663	OR-268	Present	Female	745	Winter	Spawned
4/17/02	664	OR-269	Present	Male	575	Winter	Spawned
4/17/02	665	R-11913	Present	Female	730	Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/17/02	666	OR-270	Present	Female	675	Winter	Spawned
4/17/02	667	OR-271	Present	Male	966	Winter	Spawned
4/17/02	668	OR-272	Present	Male	880	Winter	Spawned
4/17/02	669	None	Absent	Male	450	Winter	Spawned
4/17/02	670	OR-273	Present	Male	750	Winter	Spawned
4/17/02	671	OR-274	Absent	Female	698	Winter	Spawned
4/17/02	672	OR-275	Absent	Female	778	Winter	Spawned
4/17/02	673	OR-276	Present	Female	746	Winter	Spawned
4/17/02	674	OR-277	Present	Female	738	Winter	Spawned
4/17/02	675	OR-278	Absent	Female	791	Winter	Spawned
4/17/02	676	OR-279	Present	Female	770	Winter	Spawned
4/17/02	677	OR-280	Present	Male	982	Winter	Spawned
4/17/02	678	OR-281	Absent	Male	815	Winter	Spawned
4/17/02	679	OR-282	Present	Male	745	Winter	Spawned
4/17/02	680	OR-283	Present	Male	755	Winter	Spawned
4/17/02	681	OR-284	Present	Male	804	Winter	Spawned
4/17/02	682	OR-285	Present	Male	934	Winter	Spawned
4/17/02	683	OR-286	Present	Male	758	Winter	Spawned
4/17/02	684	OR-287	Present	Male	770	Winter	Mortality
4/17/02	685	OR-288	Present	Female	756	Winter	Spawned
4/17/02	686	OR-289	Present	Female	770	Winter	Mortality
4/17/02	687	OR-290	Present	Female	768	Winter	Spawned
4/17/02	688	OR-291	Present	Female	742	Winter	Spawned
4/17/02	689	OR-292	Present	Female	665	Winter	Spawned
4/17/02	690	OR-293	Present	Female	744	Winter	Spawned
4/17/02	691	OR-294	Present	Female	747	Winter	Spawned
4/17/02	692	R-11914	Present	Female	760	Winter	Released
4/17/02	693	R-11915	Absent	Female	726	Winter	Released
4/17/02	694	R-11916	Present	Female	707	Winter	Released
4/17/02	695	R-11917	Present	Male	780	Winter	Released
4/17/02	696	R-11918	Absent	Male	858	Winter	Released
4/17/02	697	R-11919	Absent	Female	763	No Call	Released
4/17/02	698	R-11920	Absent	Female	758	Winter	Released
4/17/02	699	R-11921	Present	Female	743	Winter	Released
4/17/02	700	R-11922	Present	Female	792	Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/17/02	701	R-11923	Present	Female	756	Non-Winter	Released
4/17/02	702	R-11924	Present	Female	720	Non-Winter	Released
4/17/02	703	R-04025	Present	Male	610	Winter	Released
4/17/02	704	R-04026	Present	Female	698	Winter	Released
4/17/02	705	R-04027	Absent	Female	757	Winter	Released
4/17/02	706	R-04028	Absent	Female	828	Winter	Released
4/17/02	707	R-04029	Absent	Female	720	Winter	Released
4/17/02	708	R-04031	Absent	Female	670	Non-Winter	Released
4/17/02	709	R-04032	Present	Female	807	Winter	Released
4/17/02	710	R-04033	Present	Unknown	704	Winter	Released
4/17/02	711	R-04035	Present	Male	718	Winter	Released
4/17/02	712	R-04036	Present	Female	768	Winter	Released
4/17/02	713	R-04037	Absent	Male	505	Winter	Released
4/17/02	714	OR-265	Present	Female	772	Winter	Released
4/24/02	715	R-04038	Absent	Female	811	Winter	Released
4/24/02	716	R-04039	Absent	Female	702	Winter	Released
4/24/02	717	R-04040	Present	Female	799	Winter	Released
4/24/02	718	R-04041	Absent	Male	525	Winter	Released
4/24/02	719	R-04042	Present	Female	803	Winter	Released
4/24/02	720	R-04043	Present	Female	745	Non-Winter	Released
4/24/02	721	R-04044	Present	Female	720	Winter	Spawned
4/24/02	722	OR-295	Present	Male	874	Winter	Spawned
4/24/02	723	OR-296	Present	Female	736	Winter	Spawned
4/24/02	724	OR-297	Present	Female	752	Winter	Spawned
4/24/02	725	OR-298	Absent	Male	771	Winter	Spawned
4/24/02	726	OR-299	Present	Male	953	Winter	Spawned
4/24/02	727	OR-300	Present	Female	718	Winter	Spawned
4/24/02	728	W-201	Present	Male	491	Winter	Spawned
4/24/02	729	W-202	Present	Female	730	Winter	Spawned
4/24/02	730	W-203	Present	Female	746	Winter	Spawned
4/24/02	731	W-204	Present	Female	771	Winter	Spawned
4/24/02	732	W-205	Present	Female	741	Winter	Spawned
4/24/02	733	W-206	Present	Female	691	Winter	Spawned
4/24/02	734	W-207	Present	Female	748	Winter	Spawned
4/24/02	735	W-209	Absent	Male	528	Winter	Mortality

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/1/02	736	R-04045	Absent	Female	735	Winter	Released
5/1/02	737	R-04046	Absent	Female	738	Winter	Released
5/1/02	738	R-04053	Absent	Female	746	Winter	Released
5/1/02	739	R-04054	Absent	Male	583	Winter	Released
5/1/02	740	R-04055	Present	Female	741	Winter	Released
5/1/02	741	R-04056	Absent	Male	549	Winter	Released
5/1/02	742	R-04057	Absent	Female	742	Winter	Released
5/1/02	743	R-04058	Absent	Unknown	713	Winter	Released
5/1/02	744	R-04059	Absent	Female	728	Winter	Released
5/1/02	745	R-04060	Absent	Female	no data	Winter	Released
5/1/02	746	R-04061	Absent	Female	750	Winter	Released
5/1/02	747	R-04063	Present	Unknown	702	Winter	Released
5/1/02	748	R-04064	Absent	Female	765	Winter	Released
5/1/02	749	R-04065	Present	Female	712	Winter	Released
5/1/02	750	R-04066	Absent	Male	677	Winter	Released
5/1/02	751	R-04067	Absent	Male	827	Winter	Released
5/1/02	752	R-04068	Absent	Female	722	Winter	Released
5/1/02	753	R-04069	Absent	Male	540	Winter	Released
5/1/02	754	R-04070	Absent	Male	515	Winter	Released
5/1/02	755	R-04071	Present	Female	743	Winter	Released
5/1/02	756	R-04072	Present	Female	699	Winter	Released
5/1/02	757	R-04073	Present	Female	801	Winter	Released
5/1/02	758	R-04074	Present	Female	792	Winter	Released
5/1/02	759	R-04000	Present	Female	670	Winter	Released
5/1/02	760	R-04001	Present	Female	688	Non-Winter	Released
5/1/02	761	R-04002	Absent	Female	672	Winter	Released
5/1/02	762	R-04003	Present	Female	no data	Winter	Released
5/1/02	763	R-04004	Present	Female	no data	Winter	Released
5/1/02	764	R-04005	Present	Female	685	No Call	Released
5/1/02	765	R-04006	Present	Female	752	Winter	Released
5/1/02	766	R-04007	Present	Female	741	Winter	Released
5/1/02	767	R-04009	Present	Female	752	Winter	Released
5/1/02	768	R-04010	Absent	Female	782	Winter	Released
5/1/02	769	W-210	Present	Male	793	Winter	Spawned
5/1/02	770	W-211	Present	Male	852	Winter	Spawned
5/1/02	771	W-212	Absent	Male	801	Winter	Spawned

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/1/02	772	W-246	Present	Male	770	Winter	Spawned
5/1/02	773	W-214	Present	Male	495	Winter	Spawned
5/1/02	774	W-215	Present	Female	765	Winter	Spawned
5/1/02	775	W-216	Present	Male	800	Winter	Spawned
5/1/02	776	W-217	Present	Male	527	Winter	Mortality
5/1/02	777	W-218	Present	Unknown	781	Non-Winter	Released
5/1/02	778	W-219	Present	Male	508	Winter	Spawned
5/1/02	779	W-220	Present	Male	485	Winter	Spawned
5/1/02	780	W-221	Present	Male	500	Winter	Spawned
5/1/02	781	W-222	Present	Male	780	Winter	Mortality
5/1/02	782	W-223	Present	Female	782	Winter	Spawned
5/1/02	783	W-224	Present	Female	820	Winter	Spawned
5/29/02	786	W-227	Present	Female	768	Winter	Spawned
5/29/02	787	R-04011	Absent	Male	514	Winter	Released
5/29/02	788	R-04012	Present	Male	658	Non-Winter	Released
5/29/02	789	R-04013	Present	Unknown	711	Non-Winter	Released
5/29/02	784	W-225	Present	Male	712	Winter	Spawned
5/29/02	785	W-226	Present	Male	871	Winter	Spawned
6/12/02	790	W-229	Absent	Male	507	Winter	Spawned
6/12/02	791	W-230	Absent	Male	550	Winter	Spawned
6/12/02	792	W-231	Present	Male	880	Winter	Spawned
6/12/02	793	R-04014	Absent	Male	457	Winter	Released
6/12/02	794	R-04015	Absent	Male	533	Winter	Released
6/12/02	795	R-04016	Present	Male	680	Non-Winter	Released
6/12/02	796	R-04017	Present	Male	656	Non-Winter	Released
6/14/02 ^a	797	W-232	Present	Male	903	Non-Winter	Released
6/14/02 ^a	798	W-233	Present	Male	733	Winter	Released
6/14/02 ^a	799	W-234	Present	Male	628	Non-Winter	Released
6/19/02	800	W-235	Present	Female	747	Winter	Spawned
6/19/02	801	W-236	Present	Male	652	Winter	Spawned
6/19/02	802	W-238	Present	Male	590	Winter	Spawned
6/19/02	803	W-239	Present	Male	595	Winter	Mortality
6/19/02	804	W-240	Present	Female	755	Winter	Mortality
6/19/02	805	W-241	Present	Male	754	Winter	Spawned
6/19/02	806	W-242	Present	Male	798	Winter	Spawned
6/19/02	807	W-243	Present	Male	696	Winter	Spawned

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
6/19/02	808	W-244	Present	Female	726	Winter	Spawned
6/19/02	809	W-245	Present	Male	588	Winter	Spawned
6/19/02	810	R-04018	Present	Male	712	Non-Winter	Released
6/19/02	811	R-04019	Present	Male	822	Winter	Released
6/19/02	812	R-04020	Present	Female	845	Non-Winter	Released
6/19/02	813	R-04021	Present	Male	776	Non-Winter	Released
6/19/02	814	R-04022	Absent	Male	542	Winter	Released
6/19/02	815	R-04023	Absent	Male	510	Winter	Released
6/19/02	816	R-04024	Absent	Male	531	Winter	Released
6/19/02	817	R-11925	Absent	Male	483	Winter	Released
6/19/02	818	R-11926	Absent	Male	no data	Winter	Released
6/19/02	819	R-11927	Absent	Male	no data	Winter	Released
6/19/02	820	R-11928	Absent	Male	572	Winter	Released
6/19/02	821	R-11929	Absent	Male	no data	Winter	Released
6/19/02	822	R-11931	Absent	Male	562	Winter	Released
6/19/02	823	R-11932	Absent	Male	571	Winter	Released
6/19/02	824	R-11933	Absent	Male	468	Winter	Released
6/19/02	825	R-11934	Present	Male	882	Winter	Released
6/19/02	826	R-11935	Present	Female	640	Non-Winter	Released
6/19/02	827	R-11936	Present	Female	630	Non-Winter	Released
6/19/02	828	R-11938	Present	Female	740	Non-Winter	Released
6/19/02	829	R-11939	Present	Female	804	Non-Winter	Released
6/19/02	830	R-11940	Present	Female	680	Non-Winter	Released
6/19/02	831	R-11941	Present	Female	720	Non-Winter	Released
6/19/02	832	R-11942	Present	Female	792	Non-Winter	Released
6/19/02	833	R-11943	Absent	Male	538	Winter	Released
6/19/02	834	R-11944	Present	Female	712	Non-Winter	Released
6/19/02	835	R-11945	Absent	Male	560	Winter	Released
6/19/02	836	R-11946	Present	Female	581	Non-Winter	Released
6/19/02	837	R-11947	Present	Male	568	Non-Winter	Released
6/19/02	838	R-11948	Present	Male	520	Non-Winter	Released
6/19/02	839	R-04475	Present	Male	720	Non-Winter	Released
6/19/02	840	R-04476	Present	Female	748	Winter	Released
6/19/02	841	R-04477	Present	Female	745	Non-Winter	Released
6/19/02	842	R-04478	Present	Female	no data	Non-Winter	Released
6/19/02	843	R-04479	Present	Female	584	Non-Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
6/19/02	844	R-04480	Present	Male	480	Winter	Released
6/19/02	845	R-04481	Present	Female	780	Non-Winter	Released
6/19/02	846	R-04482	Present	Male	590	Winter	Released
6/19/02	847	R-04483	Absent	Male	570	Non-Winter	Released
7/8/02	848	R-04487	Present	Male	851	Winter	Released
7/8/02	849	R-04488	Present	Male	561	Non-Winter	Released
7/8/02	850	R-04489	Present	Male	787	Winter	Released
7/8/02	851	R-04490	Absent	Male	520	Winter	Released
7/8/02	852	R-04491	Present	Male	668	Non-Winter	Released
7/8/02	853	R-04492	Present	Female	688	Non-Winter	Released
7/8/02	854	R-04493	Present	Female	755	Non-Winter	Released

^a Captured at Red Bluff Diversion Dam trap.

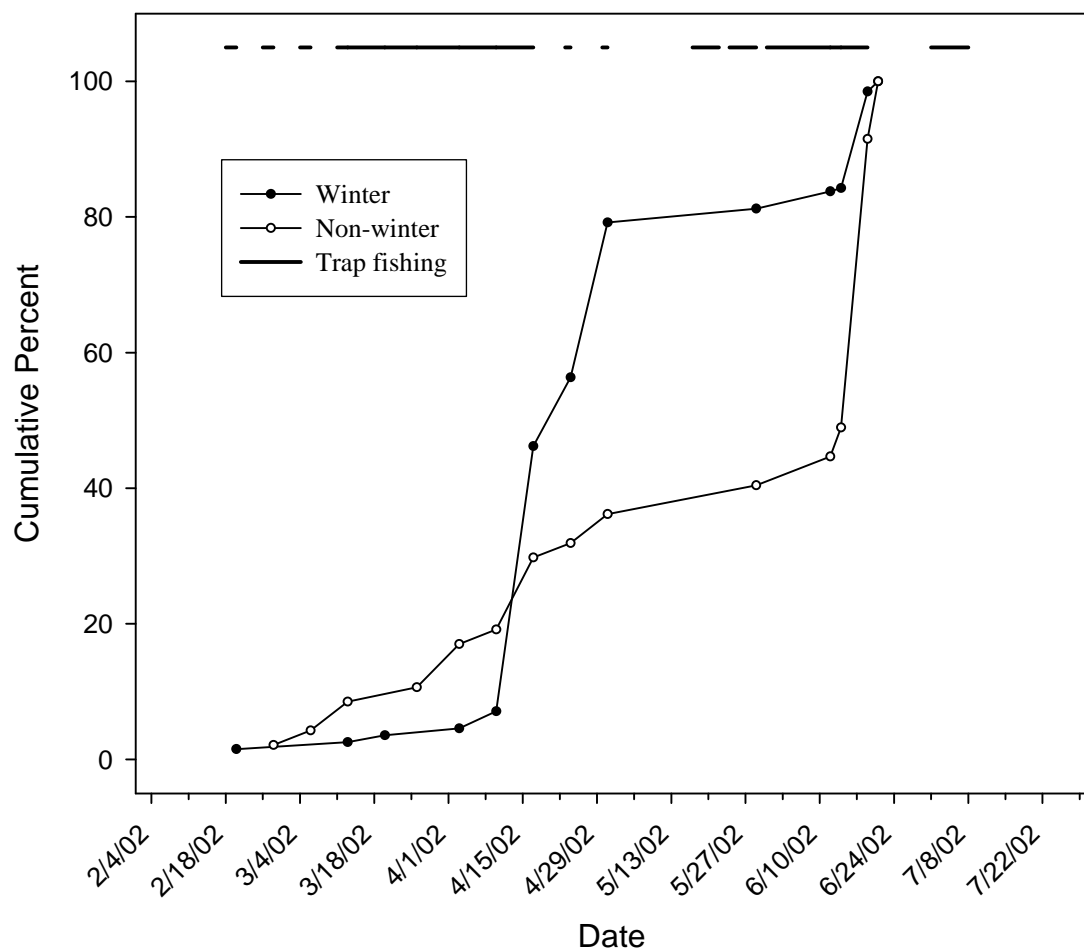


Figure 1. Capture timing of Chinook salmon from Keswick Dam trap by run-type, 2002. Dashed line across the top represents days when trap was fishing.

Table 6. Disposition of Chinook salmon trapped at the Keswick Dam trap and Red Bluff Diversion Dam trap, February 20, 2002-July 8, 2002, by run identity, trap location and gender. Numbers in parenthesis indicate the number of hatchery-origin fish included in the category total.

Run Identity	Disposition	Total All Traps				Keswick Trap				Red Bluff Diversion Dam Trap			
		Total	Males	Females	Unk.	Total	Males	Females	Unk.	Total	Males	Female	Unk.
Winter	Trapped and spawned	88 (9)	40 (6)	48 (3)	0 (0)	88 (9)	40 (6)	48 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Winter	Pre-spawn mortality	8 (1)	6 (1)	2 (0)	0 (0)	8 (1)	6 (1)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Winter	Trapped, quarantined, and released back into river	3 (2)	1 (1)	2 (1)	0 (0)	3 (2)	1 (1)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Winter	Trapped and released back into river without quarantine	98 (59)	43 (30)	52 (28)	3 (1)	97 (59)	42 (30)	52 (28)	3 (1)	1 (0)	1 (0)	0 (0)	0 (0)
	Total	197 (71)	90 (38)	104 (28)	3 (1)	196 (71)	89 (38)	104 (28)	3 (1)	1 (0)	1 (0)	0 (0)	0 (0)
Non-winter	Pre-spawn mortality	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Non-winter	Trapped, quarantined, and released back into river	5 (0)	2 (0)	1 (0)	2 (0)	5 (0)	2 (0)	1 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Non-winter	Trapped and released back into river without quarantine	50 (3)	24 (2)	25 (1)	1 (0)	48 (3)	22 (2)	25 (1)	1 (0)	2 (0)	2 (0)	0 (0)	0 (0)
	Total	55 (3)	26 (2)	26 (1)	3 (0)	53 (3)	24 (2)	26 (1)	3 (0)	2 (0)	2 (0)	0 (0)	0 (0)
Undetermined	Pre-spawn mortality	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Undetermined	Trapped, quarantined, and released back into river	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Undetermined	Trapped and released back into river without quarantine	2 (1)	0 (0)	2 (1)	0 (0)	2 (1)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Total	2 (1)	0 (0)	2 (1)	0 (0)	2 (1)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Overall Total		254 (75)	116 (40)	132 (30)	6 (1)	251 (75)	113 (40)	132 (30)	6 (1)	3 (0)	3 (0)	0 (0)	0 (0)

Health

The causative agent of bacterial kidney disease (*R. salmoninarum*) was present in broodstock from the Sacramento River and Livingston Stone (Table 7). Sacramento River broodstock also tested positive for *Aeromonas salmonicida*, *Yersinia ruckeri*, infectious hematopoietic necrosis virus and *Ceratomyxa shasta*. Captive broodstock from Bodega Marine Lab were negative for all pathogens tested for (Table 7).

Table 7. Test results (positive or negative) for fish pathogens in brood year 2002 winter Chinook salmon broodstock and juveniles, conducted by the USFWS California - Nevada Fish Health Center.

Pathogen	Brood stock origin			Juveniles ^a
	Sacramento River	Livingston Stone Captive	Bodega Marine Lab Captive	
	positive / negative	positive / negative	positive / negative	positive / negative
<i>Aeromonas salmonicida</i>	positive	no test	negative	negative
<i>Yersinia ruckeri</i>	positive	no test	negative	negative
<i>Renibacterium salmoninarum</i>	positive	positive	negative	negative
<i>Myxobolous cerebralis</i>	no test	no test	no test	negative
Infectious hematopoietic necrosis virus	positive	negative	negative	negative
Viral hemorrhagic septicemia virus	negative	negative	negative	negative
Infectious pancreatic necrosis virus	negative	negative	negative	negative
<i>Oncorhynchus masou</i> virus	negative	negative	negative	negative
<i>Ceratomyxa shasta</i>	positive	no test	no test	no test
<i>Sphaerothecum destruens</i> (Rosette Agent)	negative	negative	negative	no test

^a Juvenile progeny of the brood stock origin types were combined for the assay.

Spawning & Production- Non-captive Broodstock

In 2002, winter Chinook salmon were spawned between April 24 and July 8 and occurred at a relatively constant rate between those dates (Tables 2 and 3, Figure 2). A total of 48 female (Table 2) and 40 male (Table 3) winter Chinook salmon were spawned in 2002 producing 95 family groups (Table 8). Fork length of spawned females ranged from 665 to 818 mm and averaged 752 mm (SD 32 mm) (Table 2). Fork length of spawned males ranged from 452 to 1,000 mm and averaged 729 mm (SD 152 mm) (Table 3). Females produced an average of 4,923 green eggs yielding a total of 231,375 green eggs with 95.2% of these developing into eyed eggs (Table 8). The percent of green eggs that hatched averaged 95.8%, and 75.4% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 8).

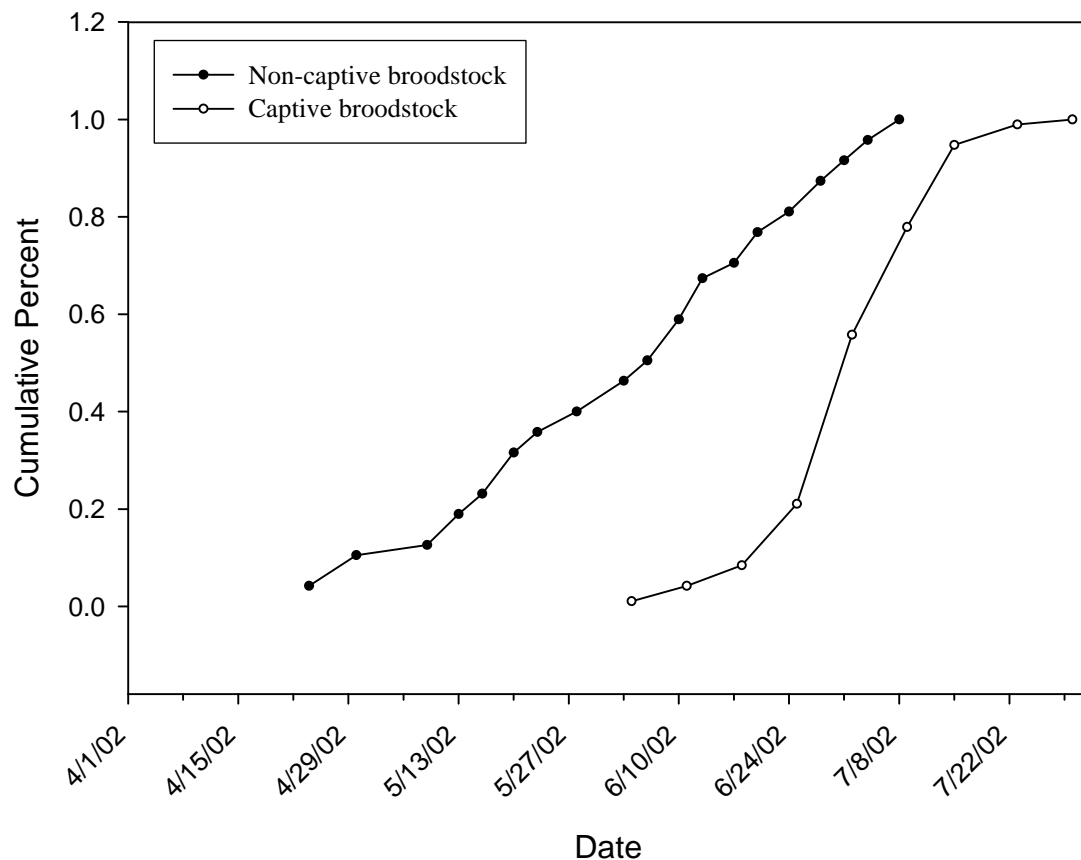


Figure 2. Spawning of winter Chinook salmon at Livingston Stone National Fish Hatchery, 2002.

Table 8. Early survival of eggs and fry from winter Chinook salmon captured from the wild and spawned at Livingston Stone National Fish Hatchery, 2002.

								Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched				
Female	Male										
OR-263	OR-251	1A	4/24/02	2,153	2,141	99.4	2,138	99.3	2,129	98.9	99.4
OR-263	OR-284	1B	4/24/02	1,906	1,897	99.5	1,895	99.4	1,876	98.4	98.9
OR-249	OR-251	2A	4/24/02	3,352	3,340	99.6	3,339	99.6	3,328	99.3	99.6
OR-249	OR-282	2C	4/24/02	2,808	2,785	99.2	2,781	99.0	2,786	99.2	100.0 ^a
OR-293	OR-251	3A	4/30/02	2,773	2,758	99.5	2,754	99.3	2,771	99.9	100.5 ^a
OR-293	OR-284	3B	4/30/02	1,955	1,939	99.2	1,935	99.0	1,939	99.2	100.0 ^a
OR-294	OR-251	4A	4/30/02	2,056	2,035	99.0	2,030	98.7	2,032	98.8	99.9
OR-294	OR-282	4C	4/30/02	2,001	1,977	98.8	1,974	98.7	1,955	97.7	98.9
OR-248	OR-284	5B	4/30/02	3,096	3,068	99.1	3,051	98.5	2,919	94.3	95.1
OR-248	OR-283	5D	4/30/02	2,373	2,324	97.9	2,315	97.6	2,152	90.7	92.6
W-224	OR-283	6D	5/9/02	3,228	3,189	98.8	0	0.0	0	0.0	0.0
W-224	OR-285	6E	5/9/02	2,928	2,892	98.8	2,883	98.5	2,807	95.9	97.1
OR-250	OR-282	7C	5/13/03	2,691	2,659	98.8	2,649	98.4	14	0.5	0.5
OR-250	OR-285	7E	5/13/03	2,622	2,586	98.6	2,576	98.2	263	10.0	10.2
OR-266	OR-285	8E	5/13/03	2,618	2,607	99.6	2,605	99.5	350	13.4	13.4
OR-266	OR-273	8F	5/13/03	2,608	2,601	99.7	2,599	99.7	32	1.2	1.2
OR-249	OR-283	9D	5/13/03	2,817	2,761	98.0	2,756	97.8	218	7.7	7.9
OR-249	OR-271	9G	5/13/03	2,715	2,672	98.4	2,671	98.4	233	8.6	8.7
OR-290	OR-271	10G	5/16/02	2,705	2,457	90.8	2,118	78.3	68	2.5	2.8
OR-290	OR-280	10H	5/16/02	2,356	2,187	92.8	1,912	81.2	575	24.4	26.3
W-205	OR-273	11F	5/16/02	2,356	2,351	99.8	2,344	99.5	0	0.0	0.0
W-205	W-205	11I	5/16/02	2,040	2,036	99.8	2,033	99.7	2,039	100.0	100.1 ^a
W-202	OR-271	12G	5/20/02	2,248	2,132	94.8	2,035	90.5	0	0.0	0.0
W-202	OR-281	12J	5/20/02	1,945	1,807	92.9	1,591	81.8	0	0.0	0.0

Table 8—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked	Percent Tanked
Female	Male							Eggs Hatched		from Green Eggs	from Eyed Eggs
OR-244	OR-273	13F	5/20/02	2,568	2,523	98.2	2,478	96.5	2,413	94.0	95.6
OR-244	OR-281	13J	5/20/02	2,800	2,752	98.3	2,704	96.6	2,758	98.5	100.2 ^a
OR-253	OR-280	14H	5/20/02	2,785	2,767	99.4	2,740	98.4	2,799	100.5	101.2 ^a
OR-253	W-212	14K	5/20/02	2,789	2,772	99.4	2,762	99.0	2,723	97.6	98.2
OR-255	W-205	15I	5/20/02	2,479	2,471	99.7	2,463	99.4	2,437	98.3	98.6
OR-255	W-212	15K	5/20/02	2,083	2,060	98.9	2,052	98.5	2,014	96.7	97.8
OR-279	W-205	16I	5/23/02	2,598	2,540	97.8	2,498	96.2	0	0.0	0.0
OR-279	OR-295	16L	5/23/02	2,271	2,242	98.7	2,188	96.3	0	0.0	0.0
OR-278	OR-280	17H	5/23/02	2,626	2,439	92.9	2,306	87.8	0	0.0	0.0
OR-278	W-210	17M	5/23/02	2,687	2,515	93.6	2,376	88.4	0	0.0	0.0
OR-268	OR-295	18L	5/28/02	2,102	1,161	55.2	951	45.2	913	43.4	78.6
OR-268	OR-298	18N	5/28/02	2,658	1,689	63.5	1,560	58.7	1,372	51.6	81.2
OR-240	W-210	19M	5/28/02	2,423	2,409	99.4	2,118	87.4	1,916	79.1	79.5
OR-240	OR-298	19N	5/28/02	2,807	2,786	99.3	2,190	78.0	2,005	71.4	72.0
OR-246	OR-295	20L	6/3/02	2,868	2,823	98.4	2,678	93.4	2,590	90.3	91.7
OR-246	W-210	20M	6/3/02	2,443	2,411	98.7	2,328	95.3	2,293	93.9	95.1
OR-261	W-226	21O	6/3/02	2,701	2,591	95.9	2,470	91.4	2,355	87.2	90.9
OR-261	W-201	21P	6/3/02	2,177	2,154	98.9	2,077	95.4	2,017	92.7	93.6
OR-252	W-226	22O	6/3/02	2,129	1,822	85.6	1,506	70.7	1,421	66.7	78.0
OR-252	W-219	22Q	6/3/02	1,957	1,741	89.0	1,459	74.6	1,356	69.3	77.9
OR-256	W-226	23O	6/6/02	1,706	930	54.5	564	33.1	539	31.6	58.0
OR-256	W-201	23P	6/6/02	1,305	842	64.5	564	43.2	541	41.5	64.3
W-207	W-219	24Q	6/6/02	2,053	2,037	99.2	2,017	98.2	2,017	98.2	99.0
W-207	OR-272	24R	6/6/02	2,553	2,525	98.9	2,516	98.6	2,467	96.6	97.7
OR-288	W-201	25P	6/10/02	2,513	2,495	99.3	2,487	99.0	2,442	97.2	97.9

Table 8—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked	Percent Tanked
Female	Male							Eggs Hatched		from Green Eggs	from Eyed Eggs
OR-288	OR-299	25S	6/10/02	2,247	2,227	99.1	2,223	98.9	2,155	95.9	96.8
OR-276	W-219	26Q	6/10/02	2,404	2,391	99.5	2,383	99.1	2,332	97.0	97.5
OR-276	OR-299	26S	6/10/02	2,124	2,106	99.2	2,097	98.7	2,028	95.5	96.3
W-204	W-225	27T	6/10/02	2,007	1,961	97.7	1,951	97.2	1,946	97.0	99.2
W-204	W-221	27U	6/10/02	2,143	2,112	98.6	2,098	97.9	2,097	97.9	99.3
OR-270	W-225	28T	6/10/02	2,202	2,100	95.4	1,685	76.5	1,641	74.5	78.1
OR-270	OR-257	28V	6/10/02	2,133	1,701	79.7	1,303	61.1	1,251	58.6	73.5
W-206	OR-257	29V	6/13/02	2,177	2,119	97.3	2,067	94.9	2,119	97.3	100.0 ^a
W-206	OR-258	29W	6/13/02	2,237	2,182	97.5	2,148	96.0	2,156	96.4	98.8
OR-260	W-226	30O	6/13/02	3,009	2,938	97.6	2,876	95.6	2,941	97.7	100.1 ^a
OR-260	W-221	30U	6/13/02	2,943	2,840	96.5	2,772	94.2	2,826	96.0	99.5
W-223	OR-272	31R	6/13/02	3,136	2,973	94.8	2,951	94.1	3,052	97.3	102.7 ^a
W-223	W-225	31T	6/13/02	2,545	2,307	90.6	2,270	89.2	2,390	93.9	103.6 ^a
OR-300	OR-272	32R	6/13/02	2,625	2,559	97.5	2,539	96.7	2,565	97.7	100.2 ^a
OR-300	OR-286	32Y	6/13/02	2,867	2,781	97.0	2,737	95.5	2,704	94.3	97.2
W-203	OR-258	33W	6/17/02	2,515	2,208	87.8	2,172	86.4	2,110	83.9	95.6
W-203	W-231	33X	6/17/02	2,805	2,719	96.9	2,668	95.1	2,530	90.2	93.0
W-215	OR-258	34W	6/17/02	3,068	320	10.4	327	10.7	323	10.5	100.9 ^a
W-235	OR-286	35Y	6/20/02	2,620	2,606	99.5	2,587	98.7	2,536	96.8	97.3
W-235	OR-269	35Z	6/20/02	2,623	2,592	98.8	2,578	98.3	2,542	96.9	98.1
W-227	OR-264	36AA	6/20/02	2,179	2,166	99.4	2,163	99.3	2,136	98.0	98.6
W-227	W-213	36BB	6/20/02	2,317	2,289	98.8	2,282	98.5	2,143	92.5	93.6
OR-274	OR-257	37V	6/20/02	2,270	2,246	98.9	2,234	98.4	2,189	96.4	97.5
OR-274	OR-264	37AA	6/20/02	1,898	1,873	98.7	1,868	98.4	1,845	97.2	98.5
W-244	W-236	38CC	6/24/02	2,571	2,551	99.2	2,538	98.7	2,408	93.7	94.4

Table 8—cont.

Crosses by tag number								Percent Green		Percent Tanked	Percent Tanked
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Eggs Hatched	Number Tanked	from Green Eggs	from Eyed Eggs
W-244	W-242	38DD	6/24/02	2,523	2,512	99.6	2,495	98.9	2,338	92.7	93.1
OR-291	W-213	39BB	6/24/02	2,614	2,554	97.7	2,543	97.3	2,505	95.8	98.1
OR-291	W-236	39CC	6/24/02	2,618	2,560	97.8	2,549	97.4	2,531	96.7	98.9
OR-296	W-220	40EE	6/28/02	2,393	2,374	99.2	2,367	98.9	2,362	98.7	99.5
OR-296	W-229	40FF	6/28/02	2,566	2,545	99.2	2,539	98.9	2,503	97.5	98.3
OR-292	W-242	41DD	6/28/02	1,392	1,364	98.0	1,357	97.5	1,320	94.8	96.8
OR-292	W-230	41GG	6/28/02	1,952	1,901	97.4	1,891	96.9	1,735	88.9	91.3
OR-245	W-241	42HH	6/28/02	2,944	2,881	97.9	2,870	97.5	2,851	96.8	99.0
OR-245	W-245	42II	6/28/02	2,769	2,749	99.3	2,743	99.1	2,742	99.0	99.7
OR-267	W-211	43JJ	7/1/02	2,456	2,413	98.2	2,405	97.9	2,401	97.8	99.5
OR-267	W-214	43KK	7/1/02	2,403	2,359	98.2	2,347	97.7	2,351	97.8	99.7
OR-275	W-220	44EE	7/1/02	2,503	2,479	99.0	2,450	97.9	2,437	97.4	98.3
OR-275	W-245	44II	7/1/02	2,415	2,384	98.7	2,339	96.9	2,311	95.7	96.9
OR-297	PW	45LL	7/4/02	1,844	1,832	99.3	1,828	99.1	1,811	98.2	98.9
OR-297	W-243	45MM	7/4/02	2,396	2,380	99.3	2,371	99.0	2,234	93.2	93.9
R-04044	OR-269	46Z	7/4/02	2,077	2,046	98.5	2,037	98.1	2,019	97.2	98.7
R-04044	W-238	46NN	7/4/02	2,212	2,187	98.9	2,172	98.2	2,143	96.9	98.0
OR-277	PW	47LL	7/8/02	2,405	2,357	98.0	2,341	97.3	2,302	95.7	97.7
OR-277	W-243	47MM	7/8/02	2,151	2,129	99.0	2,125	98.8	2,129	99.0	100.0 ^a
OR-254	W-241	48HH	7/8/02	2,319	2,299	99.1	2,294	98.9	2,290	98.7	99.6
OR-254	W-211	48JJ	7/8/02	2,327	2,319	99.7	2,317	99.6	2,311	99.3	99.7
Totals				231,375	220,189	.	210,933	.	174,465	.	.
Averages				4,923 ^b	4,685 ^b	95.2	4,488 ^b	95.8	3,712 ^b	75.4	79.2

^a Numbers of eggs, eggs hatched, and fish tanked are estimated. Error inherent in the estimates can result in anomalous results such as more fry tanked than there were eyed-eggs. ^b Averages derived from the number of females spawned (n = 47), not family groups.

Spawning & Production- Captive Broodstock

Captive-origin females from BML were spawned with natural-origin males at Livingston Stone NFH June 4 through July 30 (Table 9, Figure 2). Spawn timing of captive-origin females was much more truncated than that observed in natural-origin females. A total of 95 captive-origin female and 25 natural-origin male winter Chinook salmon were spawned in 2002 producing 95 family groups (Table 9). Females produced an average of 1,303 eggs yielding a total of 123,825 green eggs with 84.1% of these developing into eyed eggs (Table 9). The percent of green eggs that hatched averaged 62.6%, and 59.0% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 9).

To estimate fecundity and gamete viability, and evaluate maturation rates of captive winter Chinook salmon reared entirely in fresh water, captive-origin females were spawned with captive-origin males July 11 through August 15 (Table 10). A total of 37 captive-origin female and 37 captive-origin male winter Chinook were spawned producing 105 family groups (Table 10). Females produced an average of 1,274 green eggs yielding a total of 133,755 green eggs and 115,677 eyed-eggs. Percent eye-up ranged from 8.7% to 99.4 % and averaged 86.5% (SD 20.2%) across family groups (Table 10). All eyed eggs resulting from captive-origin \times captive-origin crosses were euthanized.

Table 9. Early survival of winter Chinook salmon crosses of captive-brood females raised at Bodega Marine Lab and natural-origin males, 2002.

Crosses by tag number												Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled ^b	Number Hatched	Percent Green Eggs Hatched	Number Tanked			
50335E052B	W-226	B1O	6/4/02	1,414	1,200	84.9	0	1,155	81.7	1,116		78.9	93.0
010-293-281	W-201	B2P	6/11/02	1,881	1,785	94.9	0	1,495	79.5	1,406		74.7	78.8
407F193267	W-201	B3P	6/11/02	1,400	1,367	97.6	0	1,278	91.3	1,274		91.0	93.2
011-319-099	W-226	B4O	6/11/02	1,126	1,102	97.9	0	1,068	94.8	1,052		93.4	95.5
502B7C45OE	W-231	B5X	6/18/02	1,423	1,360	95.6	0	940	66.1	912		64.1	67.1
011-020-600	W-231	B6X	6/18/02	1,172	661	56.4	0	614	52.4	617		52.6	93.3
50335D547C	W-225	B7T	6/18/02	635	571	89.9	0	523	82.4	522		82.2	91.4
010-567-342	W-225	B8T	6/18/02	924	529	57.3	0	324	35.1	304		32.9	57.5
010-317-071	OR-272	B9R	6/25/02	2,276	2,090	91.8	0	1,924	84.5	1,885		82.8	90.2
503347732E	OR-272	B10R	6/25/02	1,750	1,403	80.2	0	951	54.3	783		44.7	55.8
5033411D57	W-221	B11U	6/25/02	1,221	1,170	95.8	0	949	77.7	939		76.9	80.3
010-302-262	OR-269	B12Z	6/25/02	1,806	1,704	94.4	0	1,538	85.2	1,508		83.5	88.5
5034217471	W-213	B13BB	6/25/02	1,363	1,346	98.8	0	1,195	87.7	1,180		86.6	87.7
5033627618	W-213	B14BB	6/25/02	879	794	90.3	0	627	71.3	614		69.9	77.3
010565078	W-236	B15CC	6/25/02	1,704	1,381	81.0	0	1,328	77.9	1,307		76.7	94.6
5033381C2D	W-236	B16CC	6/25/02	1,741	1,673	96.1	0	956	54.9	931		53.5	55.6
010-868-585	W-242	B17DD	6/25/02	1,298	1,246	96.0	0	913	70.3	802		61.8	64.4
5033672724	W-242	B18DD	6/25/02	1,408	1,122	79.7	0	515	36.6	376		26.7	33.5
5033005941	OR-264	B19AA	6/25/02	1,624	1,543	95.0	0	1,181	72.7	1,083		66.7	70.2
502C032204	OR-264	B20AA	6/25/02	1,158	1,102	95.2	0	862	74.4	803		69.3	72.9
50335F5A73	W-247	B21V	7/2/02	1,166	1,100	94.3	0	890	76.3	813		69.7	73.9
011-366-207	W-247	B22V	7/2/02	680	649	95.4	0	600	88.2	589		86.6	90.8
502C053F6E	W-247	B23V	7/2/02	1,217	986	81.0	0	627	51.5	585		48.1	59.3

Table 9—cont.

Crosses by tag number												Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled ^b	Number Hatched	Percent Green Eggs Hatched	Number Tanked			
010-799-288	W-247	B24V	7/2/02	2,269	2,190	96.5	800	1,177	51.9	1,127		49.7	81.1
407F32213D	W-247	B25V	7/2/02	1,074	1,052	98.0	0	1,020	95.0	911		84.8	86.6
5033666921	W-247	B26V	7/2/02	1,081	1,027	95.0	0	645	59.7	628		58.1	61.1
011-117-813	OR-269	B27Z	7/2/02	1,492	1,427	95.6	200	1,083	72.6	988		66.2	80.5
5033446A46	OR-269	B28Z	7/2/02	891	874	98.1	0	772	86.6	765		85.9	87.5
407F267C25	OR-269	B29Z	7/2/02	789	755	95.7	0	660	83.7	1,425		180.6 ^a	188.7 ^a
502B7F0F76	OR-269	B30Z	7/2/02	1,124	875	77.8	0	758	67.4	746		66.4	85.3
010-360-878	OR-269	B31Z	7/2/02	964	852	88.4	0	575	59.6	526		54.6	61.7
5033740201	OR-286	B32Y	7/2/02	1,599	1,555	97.2	200	1,085	67.9	934		58.4	68.9
502C07787D	OR-286	B33Y	7/2/02	1,221	1,100	90.1	0	625	51.2	555		45.5	50.5
010-553-100	OR-286	B34Y	7/2/02	1,604	1,569	97.8	450	1,029	64.2	1,064		66.3	95.1
NO TAG	OR-286	B35Y	7/2/02	1,446	1,169	80.8	0	864	59.8	778		53.8	66.6
011-118-378	OR-272	B36R	7/2/02	1,420	1,409	99.2	350	1,005	70.8	1,023		72.0	96.6
407F2E5F66	OR-272	B37R	7/2/02	1,295	1,022	78.9	0	982	75.8	974		75.2	95.3
407F326649	OR-272	B38R	7/2/02	1,059	1,019	96.2	0	874	82.5	862		81.4	84.6
011-316-879	OR-272	B39R	7/2/02	1,213	1,151	94.9	100	994	81.9	996		82.1	94.8
502C043D4E	W-246	B40BB	7/2/02	1,209	1,010	83.5	0	590	48.8	560		46.3	55.4
NO TAG	W-246	B41BB	7/2/02	1,755	1,455	82.9	0	955	54.4	895		51.0	61.5
502C07457F	W-246	B42BB	7/2/02	1,409	1,321	93.8	0	957	67.9	620		44.0	46.9
010-633-029	W-242	B43DD	7/2/02	1,393	1,299	93.3	100	1,019	73.2	1,208		86.7	100.8 ^a
407F124A01	W-242	B44DD	7/2/02	2,117	2,089	98.7	900	1,046	49.4	1,197		56.5	100.7 ^a
407F160F4D	W-242	B45DD	7/2/02	1,271	1,020	80.3	0	916	72.1	890		70.0	87.3
5006651349	W-242	B46DD	7/2/02	1,115	1,005	90.1	0	841	75.4	827		74.2	82.3
010-291-585	W-242	B47DD	7/2/02	1,307	1,260	96.4	150	1,043	79.8	1,039		79.5	93.6

Table 9—cont.

Crosses by tag number											Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled ^b	Number Hatched	Percent Green Eggs Hatched	Number Tanked		
50336F170E	W-241	B48HH	7/2/02	1,541	1,488	96.6	150	1,035	67.2	810	52.6	60.5
5033692718	W-241	B49HH	7/2/02	2,271	2,179	95.9	600	1,067	47.0	1,051	46.3	66.6
NO TAG	W-241	B50HH	7/2/02	1,330	1,290	97.0	150	1,026	77.1	999	75.1	87.6
010567074	W-241	B51HH	7/2/02	945	924	97.8	0	905	95.8	985	104.2 ^a	106.6 ^a
5033726D5B	W-236	B52CC	7/2/02	1,421	1,374	96.7	100	1,028	72.3	838	59.0	65.8
50333F4A7B	W-236	B53CC	7/2/02	1,436	1,385	96.4	0	1,009	70.3	948	66.0	68.4
407F0F0C75	W-243	B54MM	7/9/02	1,869	1,816	97.2	700	1,033	55.3	1,008	53.9	90.3
50336C0537	W-243	B55MM	7/9/02	881	765	86.8	0	705	80.0	584	66.3	76.3
50065D223B	W-243	B56MM	7/9/02	1,196	1,082	90.5	0	887	74.2	751	62.8	69.4
010-893-826	W-211	B57JJ	7/9/02	724	693	95.7	0	675	93.2	569	78.6	82.1
5034203D79	W-211	B58JJ	7/9/02	1,388	1,094	78.8	0	836	60.2	738	53.2	67.5
5033423755	W-225	B59II	7/9/02	1,484	1,451	97.8	350	888	59.8	835	56.3	75.8
5033607934	W-225	B60II	7/9/02	1,526	1,481	97.1	250	978	64.1	912	59.8	74.1
407F2D4A52	W-225	B61II	7/9/02	1,237	1,197	96.8	0	997	80.6	1,093	88.4	91.3
5034177776	W-225	B62II	7/9/02	1,611	1,492	92.6	150	956	59.3	915	56.8	68.2
50336B0071	W-214	B63KK	7/9/02	974	940	96.5	0	415	42.6	387	39.7	41.2
011-114-098	W-214	B64KK	7/9/02	1,548	1,373	88.7	300	972	62.8	938	60.6	87.4
50065A3414	W-238	B65NN	7/9/02	1,690	1,478	87.5	400	1,024	60.6	682	40.4	63.3
5033456519	W-238	B66NN	7/9/02	1,663	1,516	91.2	400	1,022	61.5	864	52.0	77.4
5033454946	W-238	B67NN	7/9/02	1,335	394	29.5	0	202	15.1	126	9.4	32.0
N0 TAG	W-246	B68BB	7/9/02	845	300	35.5	0	246	29.1	221	26.2	73.7
50341C2755	W-220	B69EE	7/9/02	1,559	1,245	79.9	150	1,010	64.8	961	61.6	87.8
010-800-339	W-220	B70EE	7/9/02	1,585	1,432	90.3	250	994	62.7	918	57.9	77.7
50335F5538	W-220	B71EE	7/9/02	1,215	1,137	93.6	0	1,014	83.5	933	76.8	82.1

Table 9—cont.

Crosses by tag number											Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled ^b	Number Hatched	Percent Green Eggs Hatched	Number Tanked		
5033724027	W-221	B72U	7/9/02	691	479	69.3	0	284	41.1	287	41.5	59.9
5034237E70	W-221	B73U	7/9/02	1,158	876	75.6	0	765	66.1	724	62.5	82.6
50336B6A79	W-241	B74HH	7/9/02	1,582	1,437	90.8	200	983	62.1	860	54.4	69.5
5033742870	W-221	B75U	7/15/02	1,267	1,041	82.2	0	783	61.8	741	58.5	71.2
407F201765	W-221	B76U	7/15/02	1,414	1,301	92.0	200	992	70.2	830	58.7	75.4
5033753A2E	W-221	B77U	7/15/02	1,131	1,104	97.6	0	937	82.8	869	76.8	78.7
010-554-536	W-214	B78KK	7/15/02	1,725	1,685	97.7	650	1,006	58.3	863	50.0	83.4
500655672C	W-214	B79KK	7/15/02	884	684	77.4	0	457	51.7	432	48.9	63.2
5033671343	W-214	B80KK	7/15/02	1,061	0	0.0	0	0	0.0	0	0.0	0.0
407F181749	W-220	B81EE	7/15/02	999	65	6.5	0	44	4.4	39	3.9	60.0
5033733D48	W-220	B82EE	7/15/02	864	1	0.1	0	0	0.0	0	0.0	0.0
500667566E	W-220	B83EE	7/15/02	1,159	973	84.0	0	785	67.7	624	53.8	64.1
010-555-788	W-211	B84JJ	7/15/02	1,059	377	35.6	0	205	19.4	128	12.1	34.0
5033693766	W-211	B85JJ	7/15/02	1,511	574	38.0	0	698	46.2	378	25.0	65.9
5006573B10	W-211	B86JJ	7/15/02	1,443	460	31.9	0	353	24.5	323	22.4	70.2
407F335537	OR-286	B87Y	7/15/02	692	22	3.2	0	17	2.5	16	2.3	72.7
50336A485A	OR-286	B88Y	7/15/02	1,333	1,236	92.7	100	893	67.0	790	59.3	69.5
5033746742	OR-286	B89Y	7/15/02	1,030	949	92.1	0	664	64.5	524	50.9	55.2
010-794-080	OR269	B90Z	7/15/02	1,096	301	27.5	0	0	0.0	0	0.0	0.0
		B91B										
407F372232	OR-284	cryo	7/23/02	942	738	78.3	0	721	76.5	694	73.7	94.0
		B92A										
010-575-573	OR-251	cryo	7/23/02	378	0	0.0	0	0	0.0	0	0.0	0.0

Table 9—cont.

Crosses by tag number											Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled ^b	Number Hatched	Percent Green Eggs Hatched	Number Tanked		
50065D0E64	OR-282	B93C cryo	7/23/02	1,152	941	81.7	0	791	68.7	748	64.9	79.5
50336A764F	OR-283	B94D cryo	7/23/02	1,408	1,198	85.1	150	906	64.3	891	63.3	85.0
5033696F27	OR-285	B95E cryo	7/30/02	1,189	764	64.3	0	347	29.2	322	27.1	42.1
Totals				123,825	104,121	.	8,500	77,523	.	73,088	.	.
Averages				1,303 ^c	1,096 ^c	84.1	89 ^c	816 ^c	62.6	769 ^c	59.0	70.2

^a Numbers of eggs, eggs hatched and fish tanked are estimated. Error inherent in the estimates can result in anomalous results such as more fry tanked than there were eyed-eggs. ^b Eggs were culled to attain a desired production number from certain experimental crosses; ^c Averages derived from the number of females spawned (n = 95), not the number of family groups.

Table 10. Early survival of eggs from winter Chinook salmon crosses of captive brood females by captive brood males, 2002. All eggs resulting from these crosses were euthanized.

Crosses by tag number		Family	Date	Green	Eyed	Percent
Female	Male	Group	Spawned	Eggs	Eggs	Eyed
502C075B69	W-241	L1	7/11/02	1,300	1,287	99.0
010-877-852	W-241	L2	7/11/02	1,840	1,416	77.0
010-867-617	W-241	L3	7/11/02	1,289	1,095	84.9
407F313B42	OR-269	L4	7/18/02	2,143	2,017	94.1
503369771F	OR-269	L5	7/18/02	1,317	1,109	84.2
011-292-281	OR-269	L6	7/18/02	1,906	1,870	98.1
40332D4D0D	OR-286	L7	7/18/02	2,040	1,921	94.2
40336D4004	W-220	L8	7/18/02	1,107	984	88.9
010-883-819	W-220	L9	7/18/02	1,439	1,013	70.4
503412755A	OR-269	L10	7/18/02	1,381	1,324	95.9
502B7E6COF	W-211	L11	7/25/02	1,218	1,120	92.0
503422722C	W-211	L12	7/25/02	818	731	89.4
5033737B1F	W-211	L13	7/25/02	1,352	1,305	96.5
502C04735F	W-214	L14	7/25/02	1,182	1,115	94.3
010-881-871	W-214	L15	7/25/02	1,433	1,327	92.6
50333D7F5A	W-214	L16	7/25/02	1,259	1,003	79.7
5033411A5A	W-214	L17	7/25/02	952	923	97.0
407F260467	W-214	L18	7/25/02	1,816	1,549	85.3
50336A6859	5033693A19	L19	7/25/02	1,199	1,129	94.2
No tag	5033693A19	L20	7/25/02	1,442	1,044	72.4
50333C683F	5033693A19	L21	7/25/02	1,314	1,239	94.3
5033615D39	5033693A19	L22	7/25/02	1,142	1,096	96.0
50335F562F	5033693A19	L23	7/25/02	1,091	1,084	99.4
5033322426	503429595A	L24	7/25/02	1,503	1,488	99.0
5033666E2C	503429595A	L25	7/25/02	996	918	92.2
50065F7556	503429595A	L26	7/25/02	1,128	1,038	92.0
5006664E7B	W-211	L27	8/1/02	986	829	84.1
502B7F7E51	W-211	L28	8/1/02	903	720	79.7
5006570208	Not Recorded	L29	8/1/02	439	47	10.7
502C007802	Not Recorded	L30	8/1/02	1,240	1,203	97.0
50336C4C2B	Not Recorded	L31	8/1/02	963	920	95.5
502B7E2F61	Not Recorded	L32	8/1/02	1,028	712	69.3
011-292-077	Not Recorded	L33	8/1/02	2,042	1,888	92.5
No tag	Not Recorded	L34	8/1/02	977	889	91.0

Table 10—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed
Female	Male					
5033714E3C	Not Recorded	L35	8/1/02	1,252	1,234	98.6
5034250E0B	Not Recorded	L36	8/1/02	1,080	607	56.2
5033634B0E	Not Recorded	L37	8/1/02	1,048	841	80.2
503368436C	Not Recorded	L38	8/1/02	944	82	8.7
50066E2A75	Not Recorded	L39	8/1/02	1,357	1,343	99.0
50337367C0	Not Recorded	L40	8/1/02	1,170	223	19.1
50066D0D08	Not Recorded	L41	8/1/02	961	916	95.3
No tag	Not Recorded	L42	8/1/02	1,288	989	76.8
50336E1E7F	Not Recorded	L43	8/1/02	1,051	1,028	97.8
500658337E	Not Recorded	L44	8/1/02	1,463	1,380	94.3
503367456A	Not Recorded	L45	8/1/02	1,606	1,384	86.2
50332F2526	Not Recorded	L46	8/1/02	1,190	1,075	90.3
5033484909	Not Recorded	L47	8/1/02	1,334	1,296	97.2
50065B5254	Not Recorded	L48	8/1/02	1,255	1,228	97.8
No tag	Not Recorded	L49	8/1/02	1,368	1,315	96.1
5033471805	Not Recorded	L50	8/1/02	1,013	892	88.1
5033695B6E	Not Recorded	L51	8/1/02	958	905	94.5
407F2B480D	Not Recorded	L52	8/1/02	2,180	2,095	96.1
5033490235	Not Recorded	L53	8/1/02	774	717	92.6
5033302765	Not Recorded	L54	8/1/02	818	779	95.2
5033570B6C	Not Recorded	L55	8/1/02	1,371	1,177	85.8
No tag	Not Recorded	L56	8/1/02	1,339	1,310	97.8
502C083553	Not Recorded	L57	8/1/02	1,169	1,095	93.7
50336B7156	Not Recorded	L58	8/1/02	913	643	70.4
50065D1151	Not Recorded	L59	8/1/02	1,223	1,123	91.8
5033674936	Not Recorded	L60	8/1/02	1,133	1,095	96.6
50336F536D	Not Recorded	L61	8/1/02	1,166	1,143	98.0
5033703D3B	Not Recorded	L62	8/1/02	1,444	1,400	97.0
50065D1151	Not Recorded	L63	8/1/02	1,309	1,243	95.0
50336B684D	Not Recorded	L64	8/1/02	1,143	111	9.7
503339501C	Not Recorded	L65	8/1/02	908	839	92.4
50336474938	Not Recorded	L66	8/1/02	1,128	1,097	97.3
No tag	Not Recorded	L67	8/1/02	1,711	1,667	97.4
50336A0A17	Not Recorded	L68	8/1/02	1,198	1,150	96.0
5033634C03	Not Recorded	L69	8/1/02	1,099	650	59.1

Table 10—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed
Female	Male					
50336B300C	Not Recorded	L70	8/1/02	1,142	1,100	96.3
50335D4D67	Not Recorded	L71	8/1/02	1,519	1,029	67.7
503374750B	Not Recorded	L72	8/1/02	1,361	1,348	99.0
50333D6B3C	Not Recorded	L73	8/1/02	1,135	1,112	98.0
50340F2D38	Not Recorded	L74	8/1/02	1,371	1,307	95.3
502C2072A	407F290E3D	L75	8/8/02	1,183	626	52.9
5033654117	407F290E3D	L76	8/8/02	975	743	76.2
5033645F15	50336D664E	L77	8/8/02	1,037	912	87.9
503376267F	503348040F	L78	8/8/02	1,595	1,384	86.8
502C021754	011-055-856	L79	8/8/02	1,243	1,146	92.2
5033747F7A	011-055-856	L80	8/8/02	1,073	1,039	96.8
407F1E6431	407F114F4D	L81	8/8/02	1,561	1,477	94.6
No tag	407F114F4D	L82	8/8/02	2,085	1,922	92.2
5033622B60	407F1D4756	L83	8/8/02	900	702	78.0
5006684F5D	407F1D4756	L84	8/8/02	1,543	1,389	90.0
5033734F78	5033061E5E	L85	8/8/02	1,338	1,193	89.2
011-018-080	5033061E5E	L86	8/8/02	762	322	42.3
Not available	5033752022	L87	8/8/02	1,143	977	85.5
5006595E6F	5033752022	L88	8/8/02	1,242	1,218	98.1
502C000040	407F337C51	L89	8/8/02	1,359	1,347	99.1
Not available	407F337C51	L90	8/8/02	1,661	1,610	96.9
5033716340	407F234A6E	L91	8/8/02	1,054	975	92.5
5006574166	407F234A6E	L92	8/8/02	1,234	1,186	96.1
50066E2310	503365735E	L93	8/8/02	1,004	988	98.4
No tag	503365735E	L94	8/8/02	2,117	2,027	95.7
No tag	407F14576B	L95	8/8/02	1,231	1,192	96.8
Not available	503348040F	L96	8/15/02	1,360	300	22.1
No tag	503348040F	L97	8/15/02	1,343	1,282	95.5
5033411A0C	5033624E23	L98	8/15/02	1,332	1,305	98.0
5033636BOD	5033752002	L99	8/15/02	1,085	1,041	95.9
Not available	Not available	L100	8/15/02	1,856	532	28.7
50333B2839	Not available	L101	8/15/02	926	729	78.7
407F20364F	50341B334E	L102	8/15/02	1,226	1,187	96.8
Not available	5033696476	L103	8/15/02	2,098	1,586	75.6
50066A500F	5033696476	L104	8/15/02	1,236	1,162	94.0

Table 10—cont.

Crosses by tag number		Family	Date	Green	Eyed	Percent
Female	Male	Group	Spawned	Eggs	Eggs	Eyed
50340E6D55	407F114F4B	L105	8/15/02	876	857	97.8
			Totals	133,755	115,677	86.5

Progeny

Rearing

Between the dates of initial feeding (July 11, 2002) and release (January 30, 2003), progeny of non-captive parents were fed a total of 1,726 pounds of fish feed, resulting in a total weight gain by the fish of 1,982 pounds (food conversion rate of 0.87). The average length increase of the fish from time of initial feeding to release was 52 mm.

Between the dates of initial feeding (August 17, 2002) and release (January 30, 2003), progeny of captive-females were fed a total of 562 pounds of fish feed, resulting in a total weight gain by the fish of 535 pounds (food conversion rate of 1.05). The average length increase of the fish from time of initial feeding to release was 41 mm.

Marking and Tagging

Coded-wire tagging of juvenile winter Chinook occurred between December 16, 2002 and January 8, 2003. At the time of tagging, adipose fins were removed from all fish so they could easily be identified as hatchery-origin fish upon return. Juveniles tagged and marked included: 131,540 natural-origin \times natural-origin progeny, 23,686 natural-origin \times hatchery-origin progeny, and 67,098 captive-origin \times natural-origin progeny (Table 4). Marking and tagging mortality rates for all three groups were less than 1%. Juveniles retained for the Bodega Marine Lab (n = 208) and Livingston Stone NFH (n = 209) captive broodstock programs were tagged with passive integrated transponder (PIT) tags.

Health

Juvenile progeny of all broodstock types (Sacramento River, Livingston Stone NFH, Bodega Marine Lab) were combined and tested for eight different pathogens and all tests were negative (Table 7). Juveniles retained for the captive broodstock program at BML (n = 207) were vaccinated against *Vibrio* on April 2, 2002.

Released

A total of 233,613 juvenile winter Chinook at Caldwell Park (river mile 299) on January 30, 2003. Most (60 %) of the fish released were from natural-origin \times natural-origin parents, 11% were from natural-origin \times hatchery-origin crosses and 29% were captive-origin \times natural-origin crosses.

Assessment of Potential Genetic Impacts

When brood year 2002 hatchery propagation data was applied to the population genetics model (Hedrick et al. 1995), the model indicated loss of genetic variation due to genetic drift was not

likely to occur (Attachment A). Under the scenario that 10% of the naturally-spawning population was successful at producing progeny, the hatchery program increased the effective population size from 734 to 807 spawners. Under the scenario that 33% of the population was successful at producing progeny, the hatchery program increased the effective population size from 2,443 to 2,604 individuals.

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**Attachment A-- Brood Year 2002 Effective Population Size Methodology, Estimates,
and Assumptions**

(Note: In the event of a data discrepancy, data presented in the Propagation Report supercedes data in the following attachment.)